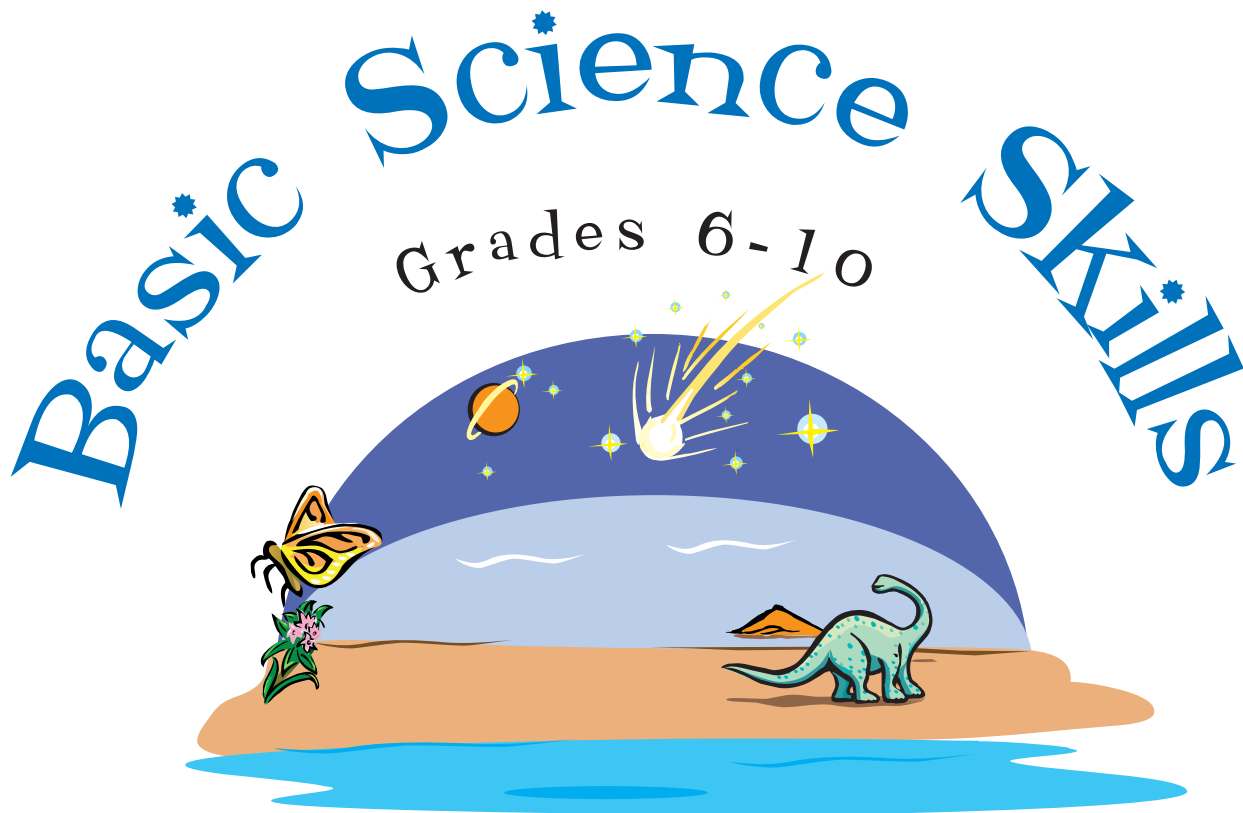




TeacherVision® Books



Brought to you by the editors of  [teachervision.com](http://teachervision.com)

# Contents

Observing .....	2
Inferring .....	5
Predicting.....	9
Classifying .....	13
Making Models .....	17
Communicating.....	20
Measuring.....	24
Measuring: Length.....	26
Measuring: Liquid Volume.....	28
Measuring: Mass .....	29
Measuring: Temperature .....	30
Calculating.....	31
Answer Key .....	34

From *Prentice Hall Science Explorer Resource Pro CD-ROM* © 2000 by Pearson Education, Inc., publishing as Pearson Prentice Hall. Used by permission.



## SKILLS INTRODUCTION

### Observing

The first day of school is an exciting time. You find out who your teachers are, who else is in your classes, and where your classrooms are. When you look around to see what the room looks like and who is there, you are making observations.

**Observing** is using one or more of your senses—sight, hearing, smell, taste, and touch—to gather information about the world. For example, seeing a green chalkboard, hearing a bell ring, smelling smoke, tasting a sour lemon, and feeling a smooth desktop are observations. Information gathered from observations is called evidence, or data. Making and recording observations is the most basic skill in science.

When you make observations in science, you want them to be accurate and objective. An accurate observation is an exact report of what your senses tell you. An objective observation avoids opinions, or bias, based on specific points of view.

**Example 1:** Sixteen students were present for roll call, and five other students arrived afterward. (accurate and objective)

**Example 2:** Half the class was late. (not accurate)

**Example 3:** The friendliest people were there first. (not objective)

Observations can be either qualitative or quantitative. Qualitative observations are descriptions that do not use numbers. For example, if you report colors, smells, tastes, textures, or sounds, you are making qualitative observations. Quantitative observations, on the other hand, do include numbers. If you count objects or measure them with standard units, you are making quantitative observations. Quantitative observations are often made using tools.

**Example 4:** The classroom walls are yellow. (qualitative)

**Example 5:** The classroom floor is shiny. (qualitative)

**Example 6:** There are 21 students in the room. (quantitative)

**Example 7:** The chalkboard is 1 meter high and 2 meters wide. (quantitative)



## Observing (*continued*)

In science, observations are usually followed by attempted explanations, or inferences. When scientists make inferences from observations, however, they keep the two processes separate. That's because although an accurate observation is considered to be factual evidence, the inferences may not be correct. When you make and record your observations, write down just what your senses perceive.

**Example 8:** There's an empty aquarium tank in the classroom.  
(observation)

**Example 9:** The tank is 50 cm long, 30 cm wide, and 18 cm deep.  
(observation)

**Example 10:** The tank used to contain live fish. (an inference, not an observation)

**Example 11:** The tank is waterproof (an inference, not an observation)



### Tips for Making Observations

---

- ◆ Use the senses of sight, hearing, touch, and smell to make qualitative observations. Important: For safety's sake, do not taste any unknown substances.
  - ◆ Review your observations to make sure they are accurate and objective.
  - ◆ Whenever possible, count or use instruments to make quantitative observations. Make sure you include the unit that identifies each measurement, such as a mass measurement of 5 grams or a distance measurement of 15 meters.
  - ◆ If no tools are available to make measurements, try to estimate common quantities by referring to known standards. For example, you might state that an object is about as long as a new pencil or has the mass of a paper clip.
  - ◆ Check your observations to be sure that they are statements about information gained through your senses, not explanations of what you observed.
- 

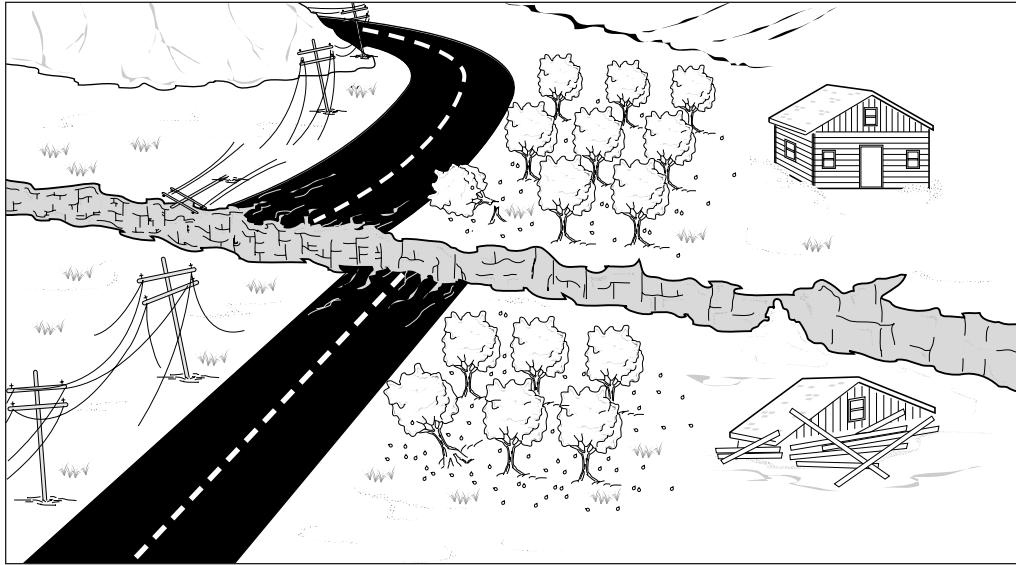
✓ *Checkpoint* Write three observations you have made today. Label each observation as qualitative or quantitative.



## SKILLS PRACTICE

### Observing

*Use the illustration to answer the questions that follow. Write your answers on the back of this page or on a separate sheet of paper.*



1. Make and record at least five qualitative observations of the scene in the illustration.
2. Explain how you could make at least three quantitative observations if you were able to visit this scene.
3. Examine the observations you wrote for Questions 1 and 2. Are any of them actually explanations, or inferences? If so, which one(s)?
4. Is the following statement an observation or an inference? "The house collapsed at the same time that the poles fell down." Explain.
5. Is the following statement an observation or an inference? "The road damage is serious, and it will be very expensive to repair." Explain.
6. Is the following statement an observation or an inference? "The house is built on unstable land." Explain.
7. Is the following statement an observation or an inference? "The damage at this scene was caused by an explosion." Explain.
8. Think About It Write a few sentences that would explain to classmates how to keep their observations separate from their inferences.

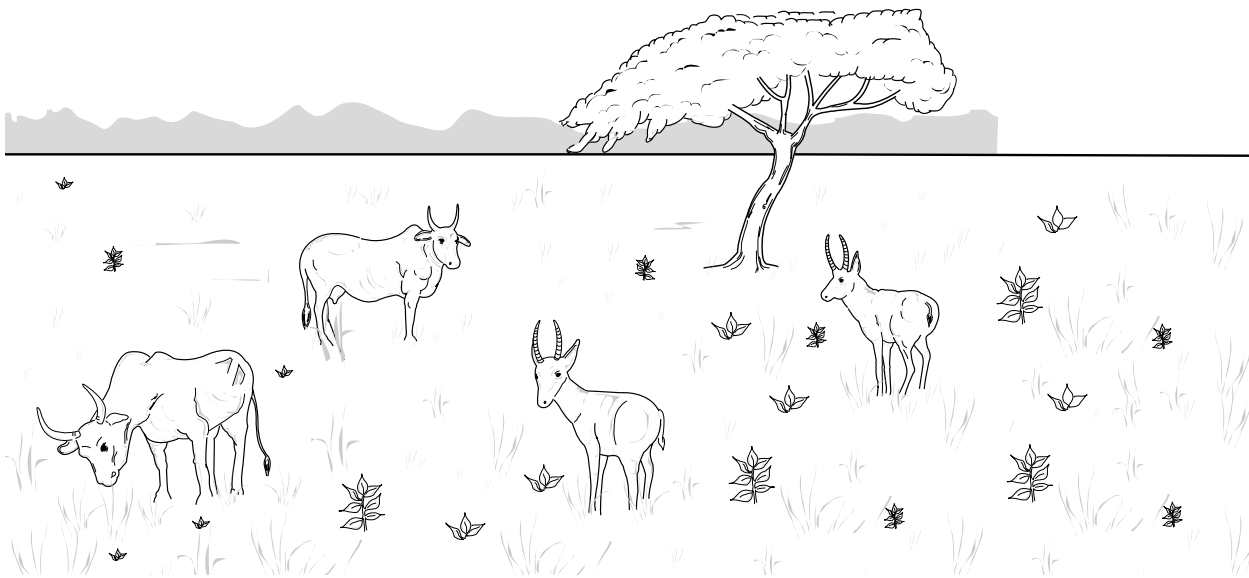


## SKILLS INTRODUCTION

### Inferring

Have you ever come home, smelled fish cooking, and thought, “We’re having fish for dinner”? You made an observation using your sense of smell and used past experience to conclude what your next meal would be. Such a conclusion is called an inference.

Making an inference, or **inferring**, is explaining or interpreting an observation or statement. Inferences can be reasonable (logical) or unreasonable. A reasonable inference is one that makes sense, given what a person knows about the topic. One way to make an unreasonable inference is to conclude too much from the evidence.



For example, suppose you are on a photo safari in Africa. In a region bordering some small farms, you see some domestic cattle sharing space with some wild antelope. Some people in your group make the following observations and inferences.

**Observation:** The cattle and the antelope are standing quietly together.

**Inference 1:** The cattle and antelope do not attack each other. (reasonable)

**Inference 2:** None of the animals in this region attack each other.  
(unreasonable, because you have no evidence about any other animals)

**Observation:** Some of the cattle are eating grass.

**Inference 3:** The grass is food for the cattle and antelope. (reasonable)

**Inference 4:** Most of the grass in this area is eaten by the cattle. (unreasonable, because you have no evidence about the amounts eaten)



## Inferring (*continued*)

Often you can make more than one logical inference from the same observation. Remember: A logical inference must make sense in terms of everything else you know.

**Observation:** The antelope are looking around.

**Inference 5:** The antelope are watching for predators. (reasonable)

**Inference 6:** The antelope are watching for potential mates. (reasonable)

**Inference 7:** The antelope heard you coming through the brush. (reasonable)


When you first make a logical inference, you may not know whether it's true or false. What's important is to make sure the inference is reasonable and based on accurate evidence. Then you can obtain additional evidence to find out whether the inference is correct. For example, if you talked to the farmers who own the cattle in the illustration, you would find out that the cattle eat grass, but the antelope do not.



### Tips for Making an Inference

---

- ◆ Base your inference on accurate qualitative or quantitative observations.
  - ◆ Combine your observations with knowledge or experience to make an inference.
  - ◆ Try to make more than one logical inference from the same observation.
  - ◆ Evaluate the inferences. Decide what new information you need to show whether your inferences are true. If necessary, gather more information.
  - ◆ Be prepared to modify, reject, or revise your inferences.
- 

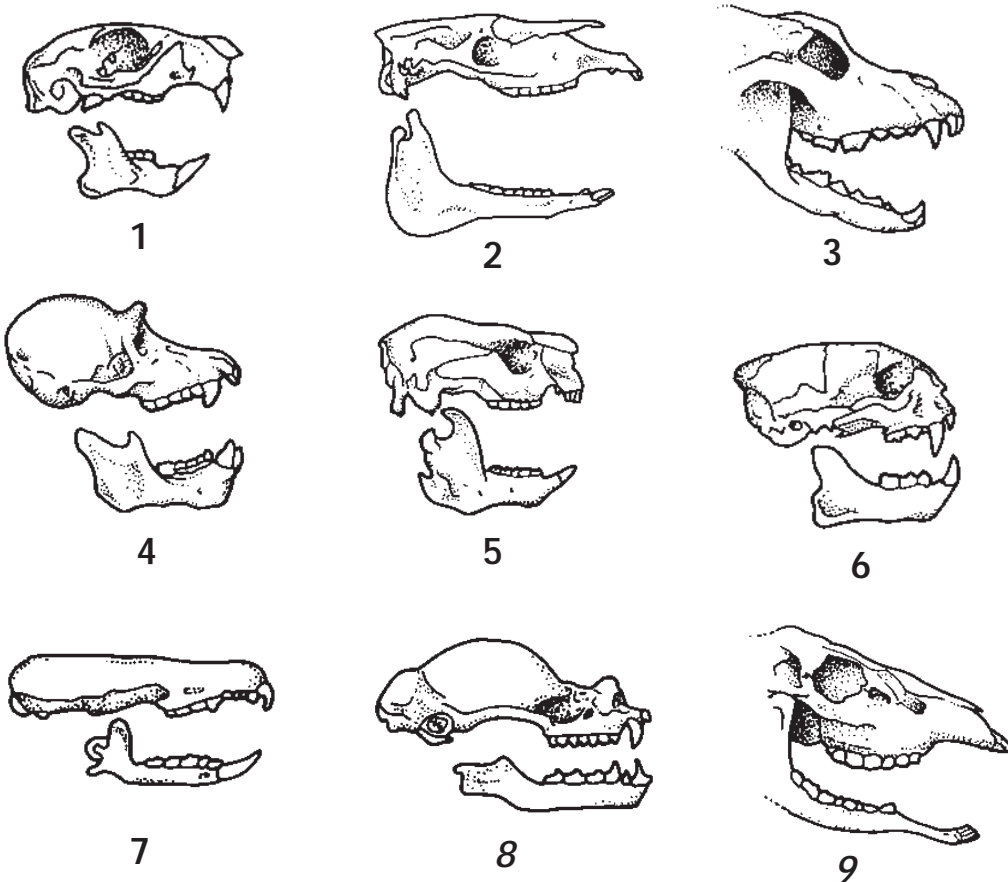
 *Checkpoint* Write at least one additional observation from the illustration on page 8. Then write at least one logical inference you can make from that observation.



## SKILLS PRACTICE

### Inferring

The diagram below shows the skulls of nine different mammals. (The skulls are not drawn to scale.) Observe the diagram and then answer the questions that follow. Write your answers on the backs of these sheets or on a separate sheet of paper.



*Not drawn to scale*

1. A mammal's teeth are adapted to its diet. Some mammals eat only plants. Many of their teeth have flat surfaces that enable the animals to crush and grind the tough material in plant parts. Which of the animals in the diagram have numerous flat teeth? What can you infer about their diet?
2. Some mammals eat other animals. Many of their teeth have sharp points that pierce animal flesh and tear off sections to swallow. Which of the animals in the diagram have numerous sharp teeth? What can you infer about their diet?
3. Some mammals eat both animals and plants. What inference can you make about their teeth? Which animals in the diagram do you think eat both animals and plants?





## Inferring (*continued*)

4. You can make other inferences from the skulls of mammals. Look for shadowy indentations and bone shapes that indicate the position and size of the eyes. Which mammals appear to have eyes side by side at the front of the head? Which mammals appear to have eyes on the sides of the head?
5. Mammals that capture other animals for food often have eyes at the front of the head. This position allows them to have excellent depth vision. Mammals that are hunted as food often have eyes on the sides of the head. These animals do not have depth vision, but they can see a larger area around them. Make inferences about the advantages and disadvantages that each type of vision might provide.
6. Which of the mammals in the diagram seems to have very small or no eyes? What might you infer about the mammal(s) based on these eyes?
7. Based on the animals' teeth and eyes, which one of these mammals, if any, might hunt other animals for food?
8. Based on the animals' teeth and eyes, which one of these mammals, if any, might eat only plant materials?
9. Based on the animals' teeth and eyes, which one of these mammals, if any, might eat both animals and plants?
10. Think About It Scientists sometimes find skulls or parts of skulls from extinct animals, ones that are no longer found alive anywhere on Earth. How might they use inferences to learn about these animals from past times?



## SKILLS INTRODUCTION

### Predicting

If a family moves into your neighborhood, your new neighbors may ask you questions like these: How many games will the school soccer team win? Will the math teacher give hard quizzes? How long will it take to get to the library? Questions like these ask you to make predictions. Predictions are a normal part of everyday life, but they also have an important place in science.

**Predicting** is making an inference about a future event based on current evidence or past experience. One way to make a prediction is to look for a pattern. For instance, depending on how many games your soccer team won last year, and whether the same players are on the team, you might make one of the predictions below. Notice that these predictions differ in how specific they are.

**Example 1:** Our team will lose a lot of games this year.  
(general)

**Example 2:** Our team will win about half of its games this year.  
(somewhat specific)

**Example 3:** Our team will win at least six games, but it will lose to Central Community School. (quite specific)

When you make a prediction in science, try to make it as specific as you can. Don't just guess. Consider all the experiences and knowledge you have about the topic. Also examine any new information you can obtain, by analyzing data tables and graphs, for example. Then make a reasonable inference based on all that information.

You may have made a logical prediction that did not come true. As a result, you probably know that predictions are not always correct. Because a prediction is an inference—an explanation or an interpretation of observations—it may not turn out to be true.

In science, predictions are usually tested. Some predictions can be tested by making observations. For instance, if someone predicts the times for sunrise and sunset over the next 30 days, you can test those predictions by using an accurate watch to time the events each day. On other occasions, carefully planned tests may be needed. For instance, suppose someone makes this prediction:

“This new medicine will prevent the common cold.”

The only way to test such a statement would be to carry out a controlled experiment. Regardless of whether tests show a scientific prediction to be true or false, making and testing predictions is a proven way of increasing people's understanding of the natural world.



## Predicting (*continued*)



### Tips for Making Predictions

---

- ◆ When you make a prediction about an event, don't just guess. Examine all the evidence that's available to you, including information in data tables and graphs. Also recall what you know about the topic.
  - ◆ Look for a pattern in the evidence or in what you know. Consider how that pattern applies to the event you're predicting.
  - ◆ If you don't have enough information, try to find out more about the event or about similar events.
  - ◆ Don't be discouraged if your prediction turns out to be false. Remember that the purpose of making a prediction in science is to learn about the natural world. Always ask yourself, "What did I learn from making and testing this prediction?" Your early incorrect predictions may lead you to new questions and new predictions that will increase your knowledge.
- 

 *Checkpoint* Explain why making a prediction in science is different from just guessing.



**SKILLS PRACTICE****Predicting**

Suppose you and your friend find a box filled with samples of different solid materials. All the samples come in cubes, and the cubes are all of the same size—1 cm on each side. (A cube is a solid figure having six square sides that are equal in size.)

You drop nine of the sample materials into a bucket of water. You observe that some cubes float. Some others sink. Using your observations and the information that comes with the samples, you make a data table that looks like this.

**Table 1: Sinking/Floating Test Results**

Sample Material	Mass of Cube	Observed Results
Apple tree wood	0.84 g	Floated
Asphalt	1.5 g	Sank
Beeswax	0.96 g	Floated
Brick	1.4 g	Sank
Cement	2.7 g	Sank
Cork	0.22 g	Floated
Granite	2.64 g	Sank
Marble	2.84 g	Sank
Paraffin	0.91 g	Floated

Your friend brags that she can predict which of the remaining cubes will sink and which will float. You challenge your friend that you can get more predictions right than she can. You make a data table like the one at the right for the remaining samples.

**TABLE 2: Sinking/Floating Test Predictions**

Sample Material	Mass of Cube	Predicted Results
Anorthite	2.74 g	
Balsa wood	0.14 g	
Charcoal	0.57 g	
Coal	1.4 g	
Diamond	3.52 g	
Dolomite	2.84 g	
Ebony wood	1.33 g	
Glass	2.4 g	
Peat	0.84 g	
Tar	1.02 g	
Sealing wax	1.8 g	



## Predicting (*continued*)

*Answer the following questions on a separate sheet of paper.*

1. One way to predict which materials will float or sink is to use your knowledge and past experience. Make as many predictions as you can about the materials listed in Table 2 on page 14. Give your reason for each prediction.
2. Examine the information provided in Table 1 on page 14. Try to find a pattern indicating why some cubes floated and some sank. Write down any pattern you find. (*Hint: You could make two new data tables, listing the materials that floated in one table and the materials that sank in the other table.*)
3. Use the pattern you found in Question 2 to predict which of the remaining sample materials will float and which will sink.
4. Do any of your predictions from Question 3 contradict your predictions from Question 1? If so, which one(s)? Which of the two different predictions do you now think is right? Explain.
5. Think About It You have probably observed that ice cubes float in water. Write a prediction stating the mass of an ice cube 1 cm on each side. Explain your prediction.

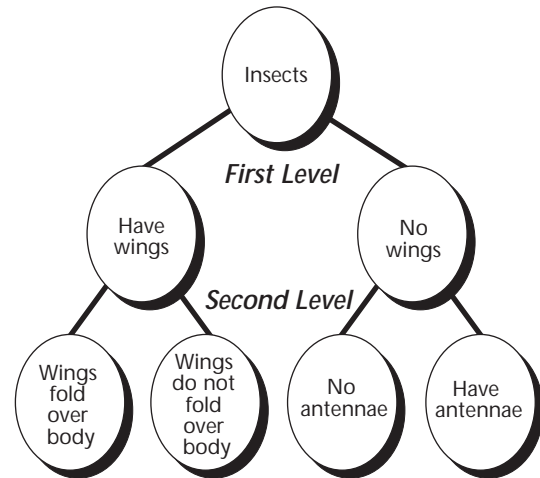


## SKILLS INTRODUCTION

# Classifying

Can you imagine shopping for a CD in a store that kept its recordings in a single, huge pile? Chances are you'd take your business to a place that classified CDs into groups, such as rock, rap, country, and other categories.

**Classifying** is organizing objects and events into groups according to a system, or organizing idea. The most simple type of classification system uses two groups, one that has a certain property and another that does not. Other systems may begin with three or more groups.



**Example 1:** Plants With Wood; Plants Without Wood (simplest system using two groups)


**Example 2:** Locations at Sea Level, Locations Above Sea Level; Locations Below Sea Level (three groups based on one idea)

Many classification systems, like the one in the diagram above, have more than one level. Each of the first-level groups in the system is further classified into smaller categories based on new organizing ideas.

In science, objects and processes can be classified in different ways. Scientists choose the system that best suits their purpose. They may classify to organize objects, such as the chemicals stored in a laboratory. They also classify to help simplify and make sense of the natural world. Good classification systems make finding information easier. They also help to clarify the relationships among the things being classified.

### Tips for Classifying

- ◆ Carefully observe the group of objects to be classified. Identify similarities and differences among the objects.
- ◆ Choose a characteristic that some of the objects share. Using this characteristic as the organizing idea, place the objects into groups.
- ◆ Examine the groups and decide if they can be further classified. Each round of further classification may need a different organizing idea.

 **Checkpoint** Develop a classification system for your clothes that has at least two levels. Write a word or phrase that shows the organizing idea for each grouping.



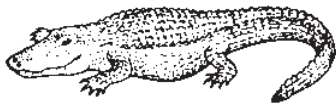
## SKILLS PRACTICE

### Classifying

The 8 rows of illustrations that follow contain 32 animals. (The illustrations are not drawn to scale.) There are many different ways to classify these animals. As you try out various organizing ideas, don't be discouraged if you have to revise some of those ideas.

*Use the illustrations to answer the questions on page 19.*

1.



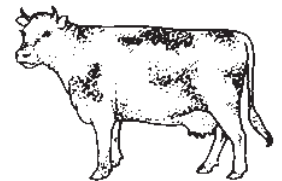
*Alligator*



*Bluebird*

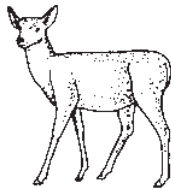


*Chicken*

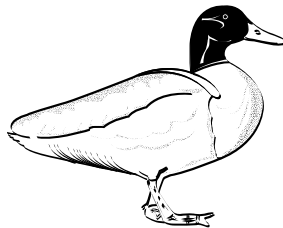


*Cow*

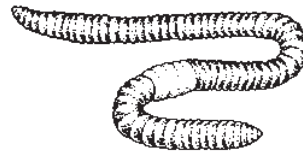
2.



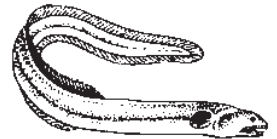
*Deer*



*Duck*

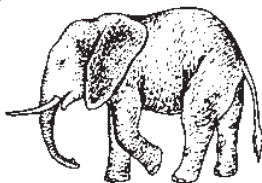


*Earthworm*

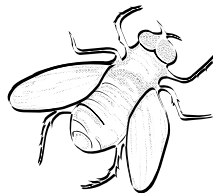


*Eel*

3.



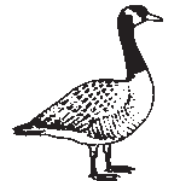
*Elephant*



*Fly*



*Frog*

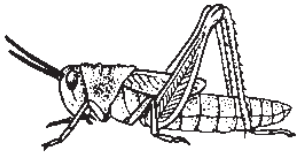


*Goose*

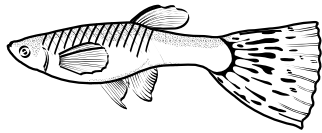


## Classifying (*continued*)

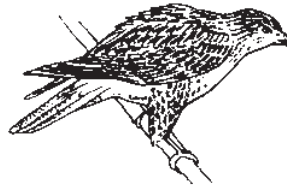
4.



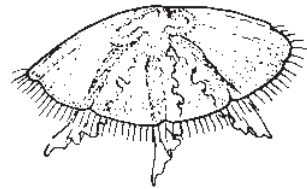
*Grasshopper*



*Guppy*



*Hawk*

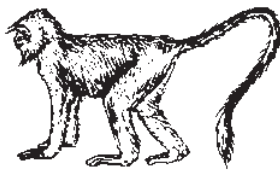


*Jellyfish*

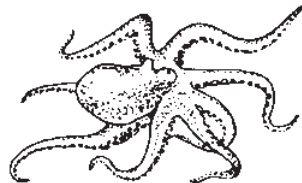
5.



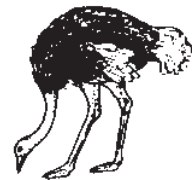
*Lizard*



*Monkey*

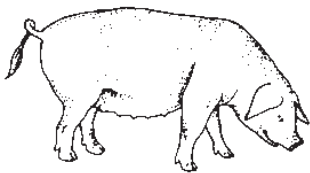


*Octopus*

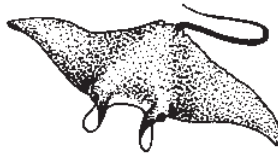


*Ostrich*

6.



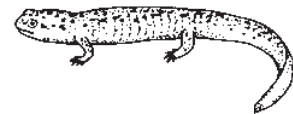
*Pig*



*Ray*

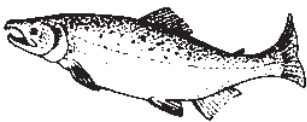


*Robin*

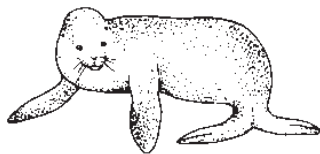


*Salamander*

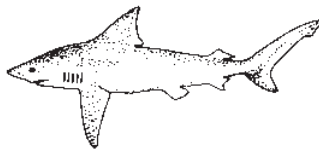
7.



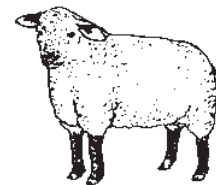
*Salmon*



*Seal*

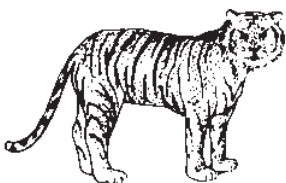


*Shark*

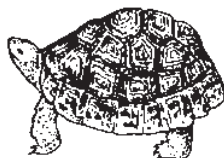


*Sheep*

8.



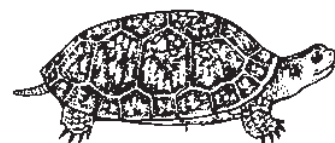
*Tiger*



*Tortoise*



*Tuna*



*Turtle*





## Classifying (*continued*)

*Use the illustrations on pages 17 and 18 to answer the following questions. Write your answers on the back of this page or on a separate sheet of paper.*

1. Develop a classification system for the animals that contains just 2 groups.  
Give a name to each group, and classify the animals according to this system.
2. Develop a classification system for the animals that uses 3–5 groups. Give a name to each group, and classify the animals according to this system.
3. Develop a classification system for the animals that contains 2 levels. You can use one of your systems from Questions 1 and 2, or develop a new system. Use a diagram to show all the groups in your system.
4. Classify the animals according to the system that you developed in Question 3.  
(*Hint:* You may want to use a data table to organize your lists.)
5. Suppose that you are designing a zoo. Your goal is to prepare exhibits that will be easy to maintain. Would you use any of your classification systems from Questions 1–4 to plan the zoo? Explain.
6. Think About It Which of the classification systems that you developed in Questions 1–4 would help you learn the most new information about animals? Explain.



## SKILLS INTRODUCTION

### Making Models

You may know someone who builds model trains, ships, or dollhouses as a hobby. In some occupations, people use models to plan complex objects, such as buildings. Models also play a role in science. Scientific **models** are pictures, diagrams, or other representations of objects or processes. Models may be created on paper or a computer, or may be made of wood, metal, plastic, or other materials. Making scientific models helps people understand natural objects and processes.

There are two main types of models. Physical models, such as model skeletons, usually look like the object or process being modeled. Mental models, such as mathematical equations, represent ideas about objects or processes that often cannot be directly observed. For example, for centuries, most people thought that the world was flat. A few scientists developed the hypothesis that Earth is shaped like a ball. They could then make a mathematical model that included the diameter of Earth and use an equation to find Earth's surface area.

Physical models can be either two-dimensional (flat), such as a map, or three-dimensional (with depth), such as a globe. Scientists often use physical models to represent things that are very large (such as the solar system), very small (atoms), or not easily visible (bacteria). Some models are drawn "to scale." That means that the measurements of the model are in proportion to the actual object. For example, a model may be 100 times larger than or  $\frac{1}{10}$  the size of the actual object.



#### Tips for Making Models

- ◆ Identify the purpose of the model and the type of model to be used (physical or mental, two-dimensional or three-dimensional).
- ◆ If you are modeling a process, try to think through the entire process and identify its steps in order.
- ◆ If you are making a physical model, determine what materials you will use.
- ◆ Decide whether the model will be larger than, smaller than, or the same size as the real object. Will it be made to scale? If so, what scale?
- ◆ Make a plan before you begin making the model. Use pencil to list or draw your ideas, and have an eraser handy so you can revise your plan easily. Be prepared to explain any important differences between the model and the real thing.

✓ *Checkpoint* What do scientific models have in common with models people make for enjoyment? How are the two kinds of models different?



**SKILLS PRACTICE****Making Models**

*Use a separate sheet of graph paper to make each of the two models described below. To obtain the measurements you need, use a meter stick or make estimates. Then answer the following questions on a separate sheet of paper.*

Suppose that your school principal is considering changing the way your classroom is arranged. To help in the planning, you are asked to (1) make a two-dimensional scale model of your classroom as it is; (2) make a similar model to show how the classroom might be rearranged; (3) explain whether or not your new arrangement is an improvement over the current arrangement.

1. Read over the rest of the assignment. Make a plan of your tasks, such as taking certain measurements or listing objects that will appear in your model. Decide whether you will use a meter stick to obtain actual measurements of objects and distances, or if you will estimate those measurements.
2. Measure or estimate the size of your classroom floor. What are the room's length and width?
3. What scale will you use to draw the floor? (*Hint:* Decide how many squares on your graph paper will represent the length of your classroom. For example, if the room is 18 meters long, you could use a scale in which the length of 1 square represents 1 meter.) Find a place on the graph paper to describe your scale, and write in that scale.
4. Draw the length and width of the classroom floor to scale on the graph paper. Using the same scale, draw the major structures around the edge of the room, such as doors, closets, and bookshelves. Label these structures.
5. Using the same scale, draw in the main pieces of furniture within the classroom, such as the teacher's and students' desks and chairs and any other items you think are important. Label these objects.
6. Use a new sheet of graph paper to make a new model showing a different classroom arrangement. Keep the floor the same size and show the same number of desks and chairs. Show the location of all structures that appear in your first model. (*Hint:* Remember to label all structures and objects.)
7. Use your models to decide which classroom arrangement works better. Be sure to consider such needs as making quick exits during fire drills and giving all students access to the bookshelves. Explain which version you prefer, and give your reasons.
8. Think About It Do you think a physical model has to show every part of the object or process being modeled? Use the models you just made to help explain your response.



**Name** \_\_\_\_\_ **Date** \_\_\_\_\_ **Class** \_\_\_\_\_

## Making Models *(continued)*

[illegible]

## SKILLS INTRODUCTION

# Communicating

You have probably waved to a friend from a distance, written someone a note, and had more conversations than you can count. Whenever you send messages to, or receive messages from, another person, you are **communicating**. Since you've been communicating your whole life, you may wonder what else you need to learn about the topic.

Now you are learning how scientists communicate. In science, observations and experiments should be reproducible. That means that any scientist should understand and be able to repeat the work of another scientist. To make such repetition possible, scientists follow certain rules when they communicate.

- ◆ The descriptions of all procedures must be understandable and complete. Someone else should be able to repeat the entire procedure step by step.
- ◆ Observations, or evidence, must be recorded accurately and in total. Researchers who observe unexpected or puzzling results must report these results.
- ◆ The observations should be discussed separately from the inferences, or explanations of the observations. Other scientists may make different inferences from the same observations.
- ◆ Scientific work should be objective—free from bias. In science, being free from bias means considering all reasonable explanations instead of just trying to prove a specific idea.

As you study science, you'll have many opportunities to communicate, sometimes orally and other times in writing.

**Oral Communication** Scientific communication may occur orally. Scientists frequently share their ideas in person and by telephone. You too will have opportunities to talk about science topics when you work in small groups or make presentations to your class. Besides observing the rules described in the previous section, try to remember the following:

- ◆ Your ideas may be new to your audience. Watch people's faces to see if they understand you. You may need to repeat an idea or explain it in a different way.
- ◆ Consider using visuals or models. In small groups, you could make simple sketches. For class presentations, you could prepare larger, more complex displays.



## Communicating (*continued*)

**Written Communication** Most scientific communication occurs through the written or printed word. New research is nearly always reported in printed form, usually in science journals. Similarly, you may need to write up the procedures and results of your experiments in a lab report. Lab reports usually contain the following sections, in this order:

- (1) problem or question
- (2) hypothesis
- (3) list of materials
- (4) procedure
- (5) observations, often organized in data tables
- (6) analysis, including any calculations and graphs
- (7) conclusions

Sometimes lab reports end with additional questions suggested by the conclusion or ideas for additional experiments.



### Tips for Communicating in Science

---

- ◆ Describe your observations honestly and completely. Write what you actually observe, not what you expected to observe or hoped would happen.
  - ◆ Record your observations as clearly and efficiently as possible, for example, using data tables. If you make data tables afterward, always create those data tables from your original notes. Don't rewrite your notes to make them sound better.
  - ◆ Keep a written record of your procedures, including any changes you make as you work. Always be prepared to communicate your procedures to others.
  - ◆ Present your observations and your inferences separately.
  - ◆ Use graphs and diagrams when they will help interpret your data. If you carry out calculations, show the formula or describe the mathematical operations you performed.
  - ◆ Follow any rules or guidelines that apply to the specific type of communication, for example, lab reports, science fair presentations, and class projects.
  - ◆ If you use information from other people's work, keep a record of those references and the information you obtained from them. Be prepared to provide the names of your sources.
- 

✓ *Checkpoint* How do the rules for scientific communication make it possible for scientists to check each other's work?



**SKILLS PRACTICE****Communicating**

*Use the student notes below to write a lab report. The questions on page 26 will help you with the main sections of the report. You will need a sheet of graph paper.*

While Tom carried out a science investigation, he wrote the following information in his laboratory notebook. Write a lab report for his investigation.

	Today we put boiling water into four different containers. I thought the containers with a vacuum would be the best containers for keeping the water hot. Then we measured the temperature of the water in each container.
	At first we checked the temperatures every 10 minutes. Later we checked every 20 or 30 minutes. Here's the list of the times when we took temperature readings, in minutes: 10, 20, 30, 40, 60, 90, 120, 150.
	We used a Celsius thermometer. Here are the temperatures we found:
	First container: 100, 99, 95, 91, 88, 83, 74, 67, 65
	Second container: 100, 100, 99, 99, 98, 97, 96, 95, 94
	Third container: 100, 97, 94, 91, 88, 82, 75, 68, 65
	Fourth container: 100, 99, 98, 97, 97, 95, 94, 93, 92
	I think we can use these tests to figure out which container is the best container to use for soup and hot drinks. The containers are the same except for these two differences:
	1. The first and second containers have a silver layer in them. The third and fourth containers don't have a silver layer.
	2. The second and fourth containers have a vacuum between their layers. The first and third don't have a vacuum between the layers. (A vacuum is a space with the air taken out.)



## Communicating (*continued*)

1. Read over Tom's notes on page 25. Write a sentence describing the problem or question that he was investigating.
2. Write out the hypothesis Tom was testing in the investigation. (*Hint: Try to write the hypothesis as a prediction using the words **If . . . then . . .***)
3. Make a list of the materials Tom used.
4. Write down the steps in the procedure Tom followed.
5. Organize Tom's observations in a data table. Use the following data table as a guide.

COMPARISON OF FOUR CONTAINERS				
Time (min)	Temperature (°C)			
	Container 1	Container 2	Container 3	Container 4

6. Analyze the data by making a graph on graph paper. (*Hint: Graph **Time** on the horizontal axis and **Temperature** on the vertical axis. Find a clear way to label the data for the four containers—for example, use four different colors.*)
7. Write a conclusion based on Tom's data.
8. Explain whether or not the conclusion you wrote supports Tom's hypothesis.
9. Write down some additional questions or ideas that Tom might investigate after completing this lab.
10. Think About It Suppose your teacher asked you to give a brief oral summary of Tom's lab to another class. Write down what you would say. Would you use any graphs or illustrations? Explain why or why not.





## SKILLS INTRODUCTION

### Measuring

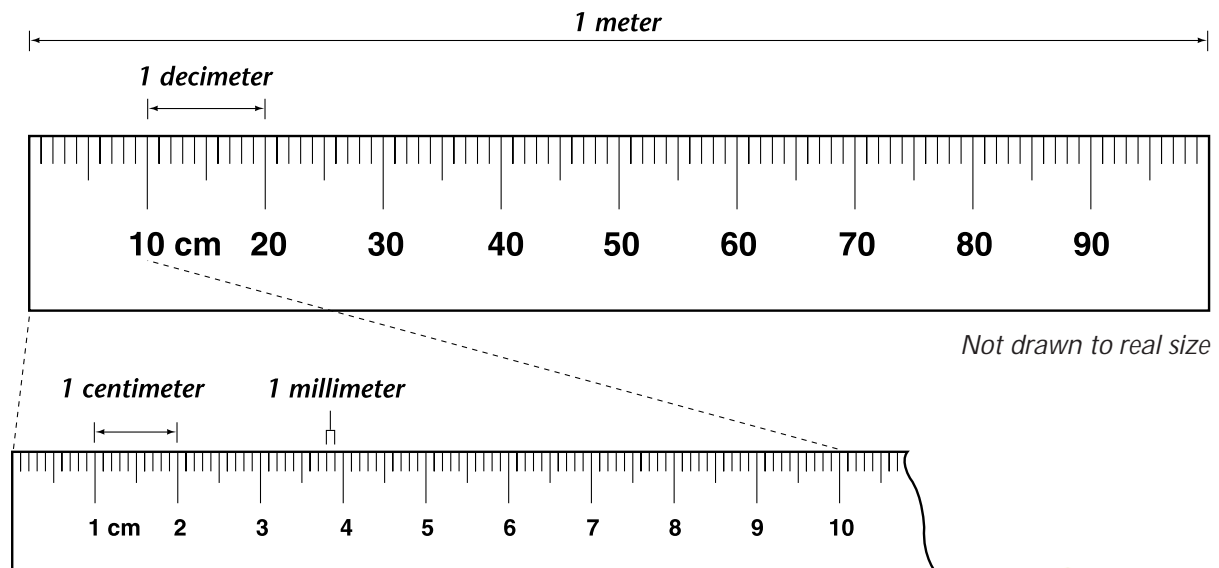
If you enjoy sports, you know how exciting it is when an athlete swims faster, runs longer, or hits a ball farther than other competitors. You also know that people aren't satisfied with descriptions like "faster" or "longer"—they want exact statistics showing just how fast an athlete ran and how great the margin of victory was. Measurements can help make sports more fun.

Common SI Units		
Property	Basic Unit	Symbol
Length	meter	m
Liquid volume	liter	L
Mass	gram	g
Temperature	degree Celsius	°C

Measurements are also important in science because they provide important specific information and help observers avoid bias. **Measuring** is comparing an object or process to a standard. Scientists use a common set of standards, called the International

System of Units. This system is often abbreviated as SI (for its French name, *Système International d'Unités*). The table above lists the basic units for four common properties.

The basic unit for length is the meter. For a property such as length, researchers often need to measure amounts that are much smaller or much larger than the basic unit. In the SI system, the smaller or larger units are based on multiples of 10. For example, notice that the meter below is divided into 10 main sections, called decimeters. Each decimeter is then divided into ten sections, called centimeters. That means that a decimeter is  $\frac{1}{10}$  (or 0.1) of a meter. A centimeter is  $\frac{1}{100}$  (or 0.01) of a meter. A millimeter is  $\frac{1}{1,000}$  (or 0.001) of a meter.



## Measuring (*continued*)

The same prefixes that are used for naming smaller and larger units of length are also used for naming different size units of volume and mass. Look at the chart below to see the meaning of some common prefixes.

Common SI Prefixes			
Prefix	Symbol	Meaning	Example
kilo-	k	1,000	kilometer (km)
hecto-	h	100	hectometer (hm)
deka-	da	10	dekameter (dam)
deci-	d	0.1 ( $\frac{1}{10}$ )	decimeter (dm)
centi-	c	0.01 ( $\frac{1}{100}$ )	centimeter (cm)
milli-	m	0.001 ( $\frac{1}{1,000}$ )	millimeter (mm)



### Tips for Making Measurements

- ◆ Know the purpose of your measurement. Choose the most suitable size unit, for example, centimeters for a book or meters for the classroom floor.
- ◆ Know how your measuring tool works, for example what main units it measures and what the smaller units mean.
- ◆ Always label your measurements. If you perform any math operations such as adding or subtracting measurements, always label the resulting numbers properly.
- ◆ Determine whether you will need one, two, or a series of measurements. Figure out whether you will have to perform any math operations. For example, if you need to find how much the temperature of a liquid increased, you will need to subtract the original temperature from the final temperature.
- ◆ Know any special rules that apply. For example, read the water level in a graduated cylinder at eye level and at the lowest point of the curved surface.

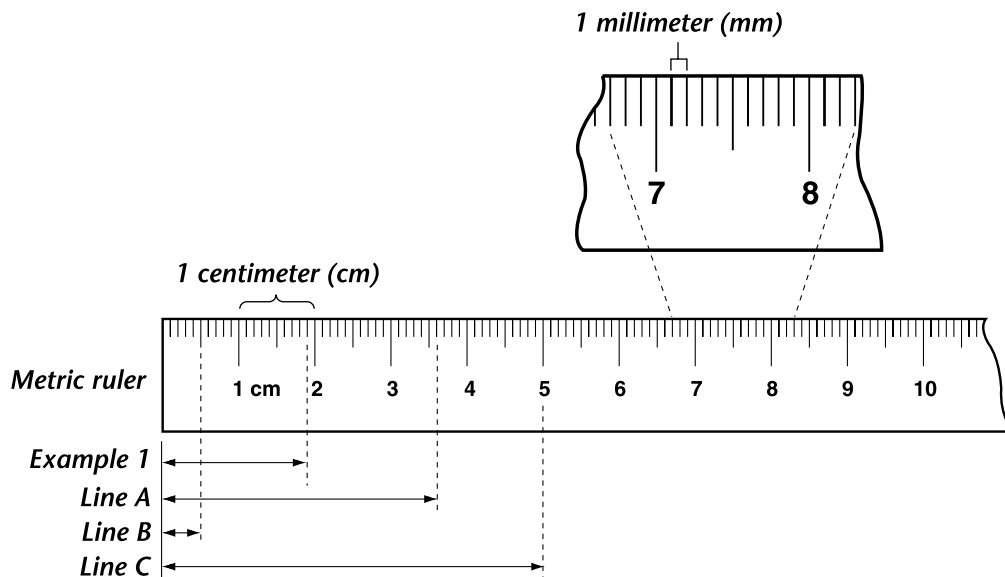
✓ *Checkpoint* How could you demonstrate that there are 1,000 millimeters in 1 meter?



**SKILLS PRACTICE****Measuring: Length**

*Write your answers to the questions below in the spaces provided. If you need more space, use the back of this sheet.*

Length is the distance between two points. Length is usually measured with rulers. Examine the metric ruler diagramed below. Notice that the labeled units are in centimeters (cm). Small vertical lines separate each centimeter into 10 sections. Each of these sections measures 0.1 (or  $\frac{1}{10}$ ) of a centimeter, which equals 1 millimeter (mm). When you use a metric ruler, decide which of these units you will use. For example, if you measure the line in Example 1 in millimeters, you would say it's 19 mm long. If you measure it in centimeters, you would say it's 1.9 cm long.



1. How many millimeters long is Line A? \_\_\_\_\_
2. How many centimeters long is Line A? \_\_\_\_\_
3. How many millimeters long is Line B? \_\_\_\_\_
4. How many centimeters long is Line B? \_\_\_\_\_
5. How many millimeters long is Line C? \_\_\_\_\_
6. How many centimeters long is Line C? \_\_\_\_\_

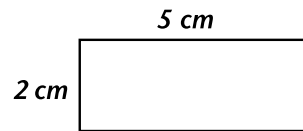
*Hint: Did you include the proper unit in each of your measurements? If not, go back and label them.*



## Measuring: Length (*continued*)

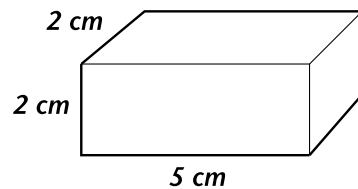
### Using Length Measurements to Find Area and Volume

You can use metric measurements to find the area of a figure by multiplying length  $\times$  width.



$$\text{Area} = 5 \text{ cm} \times 2 \text{ cm} = 10 \text{ cm}^2$$

You can use metric measurements to find the volume by multiplying length  $\times$  width  $\times$  height.



$$\text{Volume} = 5 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm} = 20 \text{ cm}^3$$

7. What is the length of the figure on the right?

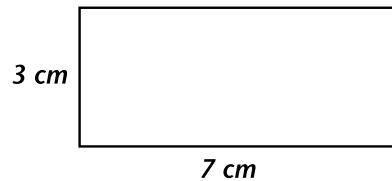
\_\_\_\_\_

8. What is the width of the figure on the right?

\_\_\_\_\_

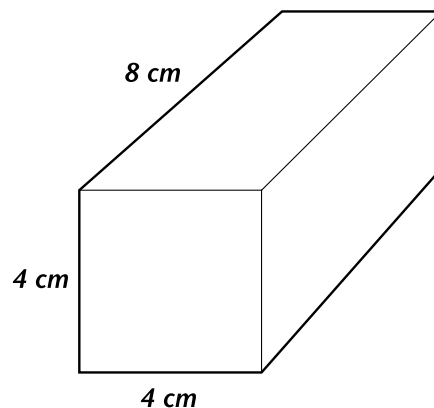
9. What is the area of the figure on the right?

\_\_\_\_\_



10. What is the volume of the figure on the right?

\_\_\_\_\_



11. Think About It If the measurements of a rectangle are 30 mm by 70 mm, would its area be the same size as the area of the rectangle for Questions 7–9? Explain.

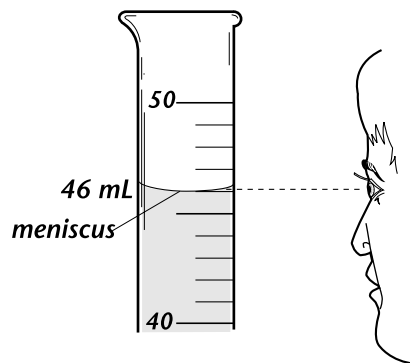


## SKILLS PRACTICE

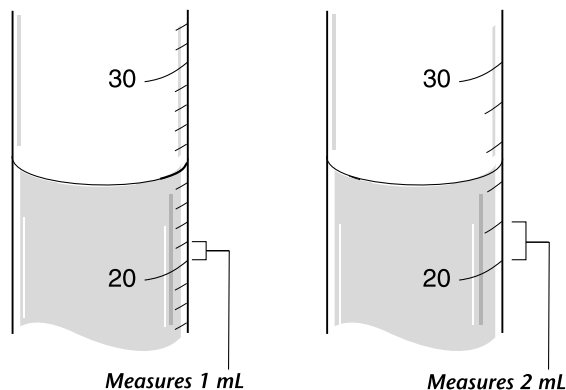
### Measuring: Liquid Volume

Write your answers to the questions below in the spaces provided. If you need more space, use the back of this sheet.

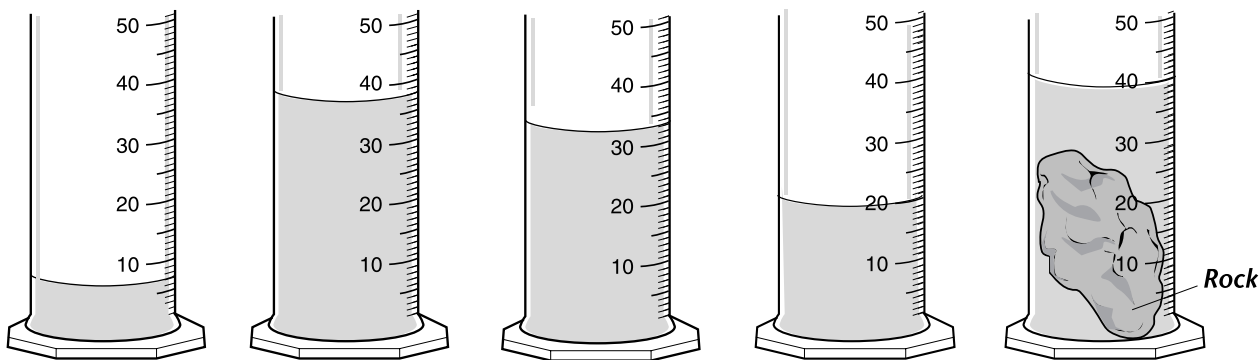
The volume of an object is the amount of space it takes up. You will often measure the volume of liquids using a graduated cylinder. ("Graduated" means that the cylinder is marked with measurement units.) Always read a graduated cylinder at eye level. Also, water in a graduated cylinder has a curved surface called the meniscus. Read the volume at the bottom of the meniscus.



**Hints:** Always check the unnumbered marks on a graduated cylinder to see how many sections there are and what they measure. Also, sometimes you have to estimate a measurement between two marks. Prove to yourself that both graduated cylinders on the right contain 25 mL.



What is the volume of the liquid shown in graduated cylinders 1–4 below? What is the total volume in graduated cylinder 5?



1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_

6. If the diagrams for Questions 4 and 5 show the same graduated cylinder before and after the rock was added, what can you infer about the volume of the rock?

7. Think About It Describe how you can use a graduated cylinder to measure the volume of an irregular object.



## SKILLS PRACTICE

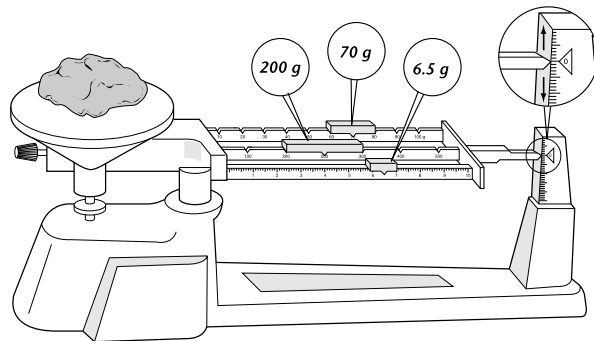
### Measuring: Mass

Write your answers to the questions below in the spaces provided. If you need more space, use the back of this sheet.

Mass is the amount of matter in an object. There are different kinds of balances used to measure mass. Be sure you understand how your balance works. Some balances give a single reading. Others give two or more readings that you have to add together.

For example, look at the triple-beam balance on the right. Notice that the middle beam measures the largest amounts. To read the mass of an object, find and record the masses shown on each of the beams. Then add the readings.

$$200 \text{ g} + 70 \text{ g} + 6.5 \text{ g} = 276.5 \text{ g}$$



*Hint:* Sometimes you have to find the mass of a substance in a container. Find the mass of the container alone. Then subtract that mass from the combined mass.

Mass of substance and container	29 g
Mass of container	<u>13 g</u>
Mass of substance	16 g

- Using the diagram on the right, find the combined mass of the substance and its container. What is the mass of the substance if the mass of the container is 25 g?

---



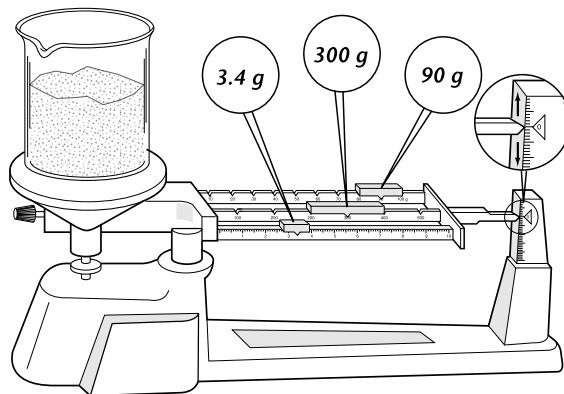
---



---

- What is the mass of a powder if the combined mass of the powder and its container is 12 grams and the mass of the container alone is 4 grams? \_\_\_\_\_

---



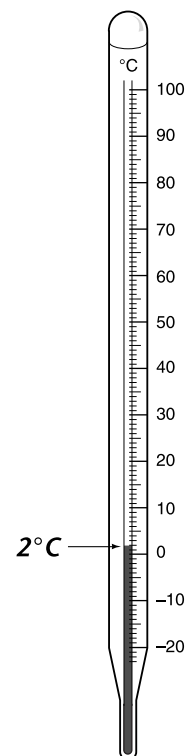
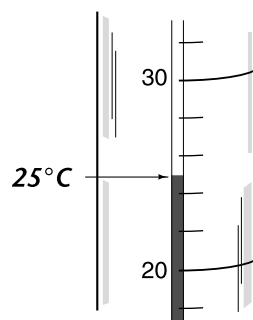
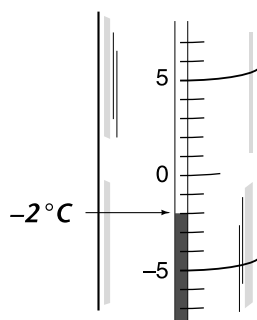
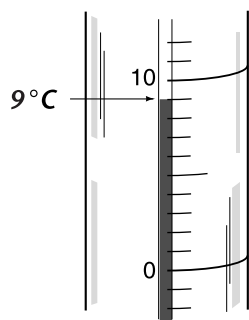
- Think About It How are the three beams on a triple-beam balance different?



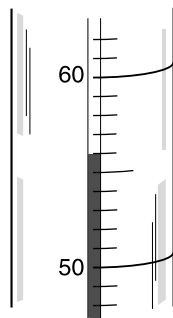
**SKILLS PRACTICE****Measuring: Temperature**

Write your answers to the questions below in the spaces provided. If you need more space, use the back of this sheet.

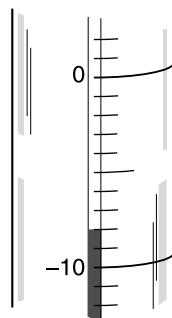
Temperature is a measure of how hot or cold something is. In science, you will measure temperature with a Celsius thermometer like the one at the right. The correct unit for readings on this thermometer is  $^{\circ}\text{C}$ . As you read the temperatures in the first three diagrams below, notice which thermometer marks are labeled and unlabeled, and determine what the unlabeled marks represent. Also, always check whether you are reading temperatures above or below zero. Temperatures below zero should be shown with a minus sign.



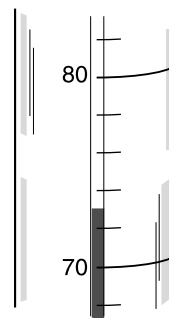
What temperature is shown in each of the diagrams below?



1. \_\_\_\_\_



2. \_\_\_\_\_



3. \_\_\_\_\_

4. Suppose that at 9:00 A.M. the temperature of a room is  $18^{\circ}\text{C}$ , and at noon it is  $24^{\circ}\text{C}$ . What was the increase in temperature? \_\_\_\_\_  
\_\_\_\_\_
5. If you add ice to water that is at  $65^{\circ}\text{C}$  and the water temperature drops to  $40^{\circ}\text{C}$ , what was the temperature decrease? \_\_\_\_\_  
\_\_\_\_\_
6. Think About It Describe how you found the temperature increase and temperature decrease in Questions 4 and 5.



**SKILLS INTRODUCTION**

# Calculating

Scientists must often solve problems that involve very large or very small numbers. For example, astronomers study galaxies with millions of stars that are at great distances from Earth. Microbiologists measure organisms or parts of organisms that can be seen only with the most powerful microscopes. Physicists investigate particles that are even smaller. Making calculations is important in the work of these and other scientists. **Calculating** is a process in which a person uses mathematical operations such as addition, subtraction, multiplication, and division to manipulate numbers and symbols.

One important type of calculation you will need to make is converting units of measure. That means changing one unit of measure into a different unit of measure that represents the same amount. For example, if you have 220 dimes, how many dollars do you have? Because you know there are 10 dimes in a dollar, you can easily convert the dimes to dollars with this procedure.

$$220 \cancel{\text{dimes}} \times \frac{\$1}{10 \cancel{\text{dimes}}} = \frac{\$220}{10} = \$22$$

In science, you will need to convert between SI, or metric, units. Like the dollar system, the SI system is a decimal system. The table below lists some common metric conversions.

Common Metric Conversions	
Length	1 km = 1,000 m
	1 m = 100 cm
	1 m = 1,000 mm
	1 cm = 10 mm
Liquid volume	1 L = 1,000 mL
Mass	1 kg = 1,000 g

For example, suppose you need to convert 117 millimeters into centimeters. One way to make the conversion is to follow the procedure that was just used to convert dimes to dollars:

$$117 \cancel{\text{millimeters}} \times \frac{1 \text{ centimeter}}{10 \cancel{\text{millimeters}}} = \frac{117}{10} \text{ centimeters} = 11.7 \text{ centimeters}$$





Calculating (*continued*)Tips for Calculating

---

*Follow these steps when converting between units.*

1. Begin by writing down the measurement you want to convert on the left side of the equation. Suppose you want to convert 1.6 liters to milliliters. Write:

$$1.6 \text{ liters} \times$$

2. Write a conversion factor that represents the relationship between the two units you are converting: *1 liter = 1,000 milliliters*. Writing this conversion factor as the correct fraction is an important step.

$$1.6 \text{ liters} \times \frac{1,000 \text{ milliliters}}{1 \text{ liter}}$$

Make sure you place the units you are starting with—liters, in this example—in the denominator. In the next step, you will see why that is important.

3. Multiply the measurement you want to convert by the conversion factor. When you multiply these two terms, the units in the first measurement will cancel out with the units in the denominator. The result will be a fraction.

$$1.6 \cancel{\text{ liters}} \times \frac{1,000 \text{ milliliters}}{1 \cancel{\text{ liter}}} = \frac{1,600.0}{1} \text{ milliliters}$$

4. Divide the numerator of the fraction by the denominator. Your answer will be in the units you are trying to find.

$$1.6 \cancel{\text{ liters}} \times \frac{1,000 \text{ milliliters}}{1 \cancel{\text{ liter}}} = \frac{1,600.0}{1} \text{ milliliters} = 1,600 \text{ milliliters}$$

---

**Checkpoint** Convert between the following units.

$$3 \text{ kilometers} = \underline{\hspace{2cm}} \text{ meters}$$

$$2,082 \text{ grams} = \underline{\hspace{2cm}} \text{ kilograms}$$



**SKILLS PRACTICE****Calculating**

*Convert between the following units. Fill in your answers in the spaces provided. Show your work below or on the back of this sheet.*

**1.** 382 milliliters = \_\_\_\_\_ liters

**6.** 3.7 liters = \_\_\_\_\_ milliliters

**2.** 2.2 decimeters = \_\_\_\_\_ millimeters

**7.** 4.1 grams = \_\_\_\_\_ milligrams

**3.** 4.5 meters = \_\_\_\_\_ centimeters

**8.** 211 centimeters = \_\_\_\_\_ meters

**4.** 0.67 liters = \_\_\_\_\_ milliliters

**9.** 0.5 kilograms = \_\_\_\_\_ milligrams

**5.** 303 grams = \_\_\_\_\_ kilograms

**10.** 17 meters = \_\_\_\_\_ centimeters

- 11. Think About It** Look over all the conversions you just made. Try to find a shortcut method for converting between one metric unit and another, for example, from milliliters to liters. (*Hint:* Examine how the position of the decimal point changed in each example.)



# ANSWER KEY

## Observing

### Introduction

**Checkpoint:** Answers will vary. Sample: There is ice on the school steps. (qualitative)

### Practice

1. Sample: Ground is broken. One house has collapsed. The highway is broken. Some telephone poles are tilted. Some wires are down.
2. Sample: Count the number of trees that are down. Measure the length of the gap in the ground. Measure the horizontal displacement of the two parts of the highway.
3. Answers will vary. Sample inference: An earthquake has occurred.
4. Inference. The illustration does not show the order of events.
5. Inference. The statement relies on cost information not shown in the illustration.
6. Inference. The illustration does not show whether the land is stable or unstable.
7. Inference. The illustration does not show what caused the damage.
8. Answers will vary. Students should include the ideas that an observation is something that you experience directly using your senses, whereas an inference is a possible explanation for an observation.

## Inferring

### Introduction

**Checkpoint:** Sample observation—Most of the plants are grasses. Sample inference—The soil conditions allow grasses to grow well.

### Practice

1. Animals 1, 2, 4, 5, 7, and 9 have numerous flat teeth. Inference: They probably eat plants.

2. Animals 1, 3, 4, 5, 6, 7, and 8 have numerous sharp teeth. Inference: They probably eat meat.
3. Mammals that eat both plants and animals probably have both sharp teeth and flat teeth. Animals 1, 4, 5, and 7 probably eat both animals and plants.
4. Mammals 3, 4, 5, 6, and 8 appear to have side-by-side eyes. Mammals 1, 2, and 9 appear to have eyes on the sides of their heads.
5. Eyes on the front of the head are advantageous because both eyes can “work together” to help the animal judge how far away a possible prey animal is. However, the animal may not see a prey animal that is too far to the side. Eyes on the sides of the head let an animal see to the side and behind, so that it could see predators creeping up on it. However, it will not be able to judge how far away the predator is.
6. Animal 7. Sample inference: This animal does not depend on its vision to survive, so it may live in the dark, such as underground or in a cave, or be active only at night.
7. Animals 3, 4, 6, and 8 might be hunters.
8. Mammals 2 and 9 might eat plants.
9. Mammals 1, 4, 5, and 7 might eat both plants and animals.
10. Sample: If an extinct animal has teeth that are similar to those of a present-day animal, it is reasonable to infer that the extinct animal ate the same types of food. Similar inferences can be made about the position of the eyes.

## Predicting

### Introduction

**Checkpoint:** A science prediction should be based on all the available evidence, including past experience.



# ANSWER KEY

## Practice

1. Answers will vary based on previous observations or past experience. Samples: Balsa and ebony will float because they are wood. Coal and glass will sink because they're too heavy to float. Sealing wax seems light, so it will probably float.
2. All the cubes that sank had a mass of at least 1.4 g. Those that floated had a mass equal to or less than 0.96 g.
3. Anorthite, coal, diamond, dolomite, and sealing wax will sink; balsa, charcoal, and peat will float. The pattern in Table 1 cannot be used to predict whether tar and ebony will float or sink.
4. Answers will vary. Sample: My predictions for sealing wax are different. I now think sealing wax will sink because the mass of the sealing wax cube is greater than 1.4 g.
5. Sample: The ice cube should have a mass less than 1.4 g.

## Classifying

### Introduction

**Checkpoint:** Answers will vary. Sample: Clothing worn during the day and clothing worn at night (time of day); subgroups winter and summer clothing (time of year).

### Practice

1. Answers will vary. Sample two-group systems: whether or not the animals live in water; whether or not they have legs; whether or not they are domesticated.
2. Answers will vary. Sample: No legs (earthworm, eel, jellyfish, ray, salmon, shark, tuna), 2 legs (bluebird, chicken, duck, goose, hawk, ostrich, robin), 4 legs/flippers (alligator, cow, deer, elephant, frog, monkey, pig, seal, sheep, tiger, tortoise, turtle), 6 legs (fly, grasshopper), 8 legs/tentacles (octopus).

3. Answers will vary. Sample answer: "Lives in water" can be further classified into "lives in fresh water" and "lives in salt water."
4. Answers will vary. Students' classifications should follow the chosen categories.
5. Answers will vary depending on students' answers in Question 1–4. Animals in a zoo could be grouped together according to their habitats, for example, fresh water, salt water, forest, open field, and so on.
6. Answers will vary. Sample: The most useful classifications are based on the animal's habitat or its body structure.

## Making Models

### Introduction

**Checkpoint:** Answers will vary. Sample: Physical models of both types look like the objects they represent. Models made for enjoyment may stress surface details, whereas scientific models may stress how things work.

### Practice

- 1–5. Answers will vary but should be accurate scale models of the classroom.
- 6–7. Answers will vary but should show an alternate arrangement of the same furniture and equipment as in the current classroom. The explanation of the preferred version should be logical and based on the model.
8. Answers will vary. Sample: I think a physical model has to show the important parts of the object so that you can see how the real object works.

## Communicating

### Introduction

**Checkpoint:** Sample—Complete, accurate communication makes it possible to repeat and verify other researchers' experiments.



# ANSWER KEY

## Practice

1. Answers will vary. Sample: What type of container is the best for keeping water hot?
  2. Sample: If the container has a vacuum, then it will keep water hot longer.
  3. containers with silver layer but no vacuum, with silver layer and vacuum, with no silver layer or vacuum, with vacuum but no silver layer; boiling water, Celsius thermometer, clock
  4. Sample: Step 1: Put boiling water into the 4 containers. Step 2: Measure the water temperature in each container. Record the temperatures. Step 3: Repeat Step 2 numerous times after the initial measurement.
  5. The table should follow the model given.
  6. The graph should be complete and correct.
  7. The two containers with a vacuum were best at keeping water hot. The container with a vacuum and a silver layer worked best of all.
  8. The conclusion supports the hypothesis.
  9. Possible questions might include these: How well do the containers keep water hot over longer time periods? Does a larger container keep water hotter than a smaller container with the same construction?
  10. Students' summaries should include the main steps of the procedure and results. Using a graph would make it easy to compare the results from the 4 containers.
2. 3.6 cm
  3. 5 mm
  4. 0.5 cm
  5. 50 mm
  6. 5 cm
  7. 7 cm
  8. 3 cm
  9.  $21 \text{ cm}^2$
  10.  $128 \text{ cm}^3$
  11. Yes; a figure 30 mm by 70 mm has the same area as one with 3 cm by 7 cm.

## Practice

1. 7 mL
2. 38 mL
3. 33 mL
4. 20 mL
5. 40 mL
6. Volume of rock:  $40 \text{ mL} - 20 \text{ mL} = 20 \text{ mL}$ .
7. Add water to a cylinder; measure the volume. Insert object; measure the volume. Subtract the first volume from the second volume to get the volume of the object.

## Practice

1. Combined mass: 393.4 g. Mass of substance: 368.4 g ( $393.4 \text{ g} - 25 \text{ g}$ )
2. 8 g ( $12 \text{ g} - 4 \text{ g}$ )
3. Each beam shows a different range of masses.

## Practice

1.  $56^\circ\text{C}$
2.  $-8^\circ\text{C}$
3.  $73^\circ\text{C}$
4.  $6^\circ\text{C}$
5.  $-25^\circ\text{C}$
6. Question 4:  $24 - 18$ ; Question 5:  $65 - 40$

## Measuring

### Introduction

**Checkpoint:** Sample—There are 100 cm in a meter and 10 mm in a centimeter.  $100 \times 10 = 1,000$ , so there are 1,000 mm in a meter.

### Practice

1. 36 mm



# ANSWER KEY

## Calculating

### Introduction

**Checkpoint:** 3,000; 2.082

### Practice

1. 0.382
2. 220
3. 450
4. 670
5. 0.303
6. 3,700
7. 4,100
8. 2.11
9. 500,000
10. 1,700
11. Sample: To change 4.5 m to centimeters, multiply by 100 ( $1 \text{ m} = 100 \text{ cm}$ ) by moving the decimal point two places to the right.

